REMARKS

Claims 1-23 are all the claims pending in the application. Claims 1 and 11 have been amended and new claims 21-23 have been added. New claim 21 corresponds to claim 18 and depends from claim 11. Support for amended claims 1 and 11 and new claims 21 and 22 can be found, for example, in the Examples, Table 1 and at page 12, line 7 of the present specification. Entry of the above amendments is respectfully requested.

Initially, Applicants thank the Examiner for acknowledging Applicants' claim to priority under 35 U.S.C. §119, and for confirming receipt of the priority document.

I. Response to rejection of claims 1-7 and 11-16 under 35 U.S.C. § 103(a)

On pages 2-3 of the Office Action, the Examiner rejects claims 1-7[2] and 11-16 under 35 U.S.C. § 103(a) as allegedly being unpatentable over Pinnow et al. (U.S. Patent 5,538,683), JP 9-263907, Cozar et al. (U.S. Patent 5,888,848) or SU 551404.

The Examiner directs Applicants' attention to col. 3, lines 3-16 of Pinnow et al., the abstract of JP 9-263907, col. 2, lines 36-53 of Cozar et al., and the abstract of SU 551404.

Applicants respectfully respond as follows.

The present invention is directed to a maraging steel having high fatigue strength which is suitably used for members, which are required to have a high fatigue strength, such as a power transmission belt, for example, in a continuously variable transmission of an automobile. In the composition of the maraging steel of the present invention, the following features are important:

(a) In order to reduce the amount of inclusion of TiN, which is detrimental to the improvement of fatigue strength, the amounts of Ti and N are not more than 0.05 % and less than 0.005 %, respectively;

(b) To reduce the production cost of the maraging steel of the invention, the amount of Co is less than 7.0 %;

(c) To compensate for decrease in tensile strength due to the reduced amount of Ti and Co, a limited amount of Si, Mn and Al are added; and

(d) To also compensate for the decrease in tensile strength, the total amount of (3Si + 1.8Mn + Co/3 + Mo + 2.6Ti + 4Al) is in the range of 8.0 to 13.0 %.

With respect to the amount of Si, Mn and Al added to the maraging steel, Al is always added because it is the most effective element among the three elements to bring about improvement in strength. Any one of the three elements, including Al, acts to form non-metallic inclusions of oxides. If most of the elements are consumed when combining with oxygen to form the oxides, the effect of the elements on improving the strength of the maraging steel becomes small. Thus, in the present invention, the amount of oxygen is limited to be not more than 0.003 %.

Because of the above features of the present invention, it is possible to obtain the novel maraging steel of the present invention, which has high fatigue strength and is suitably used for members, which are required to have a high fatigue strength, such as a power transmission belt used, for example, in a continuously variable transmission of an automobile.

Pinnow et al.:

Pinnow relates to a maraging steel for die blocks. The maraging steel of the present invention is different from that of Pinnow in that the maraging steel of Pinnow

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[2] It appears that the Examiner meant to reject claims 1-6, not claims 1-7.

contains a larger amount of Co. That is, in each of the specific examples disclosed in Pinnow, the content of Co exceeds 10 wt%.

In contrast, as explained above, an important feature of the present invention is that the content of Co contained in the maraging steel is less than 7.0 % by adjusting the amounts of the elements (particularly Al) other than Co, which makes it possible to reduce the production cost of the maraging steel, which is an advantage of the present invention. That is, a feature of the present invention does not reside only in the reduction of the amount of Co, but also resides in the adjustment of the amounts of the elements other than Co.

Since Pinnow does not teach or suggest reducing of the amount of Co so that it is less than 7 %, a person of ordinary skill in the art would not be motivated to use a lower amount of Co or to adjust the amount of the other elements to compensate for the reduction in the amount of Co, based on the disclosure Pinnow, to arrive at the maraging steel having a low Co content of the present invention.

In addition, in the present invention, the amount of Ti is also reduced to a very low level so that Ti-based inclusions from which fatigue fracture is initiated may be reduced as much as possible. However, since both Co and Ti are elements are effective in enhancing the strength of the maraging steel, the reduction of the amounts of these elements makes it impossible to obtain the characteristics of the maraging steel. Thus, an important feature of the present invention is to properly add an effective amount of Al, Si and Mn so that the reduced amounts of Co and Mo may be compensated. Specifically, in the present invention, the amounts of both Ti from which Ti-based inclusions occur and expensive Co are reduced, and Al, as well as Si and Mn, are added

to compensate for the decrease in strength due to the reduced amounts of Co and Ti. Such concept upon which the present invention is based is not disclosed in Pinnow, in which much amount of expensive Co is contained.

Further, in Pinnow, oxygen, which causes oxide inclusions by combining with Al, Si and Mn, is not mentioned at all. In the maraging steel of the present invention, it is important for the occurrence of the non-metallic inclusions, from which fatigue fracture is initiated, to be suppressed as much as possible, and it is also important for the existing inclusions to become fine in size. In the present invention, the strength is enhanced by adjusting the amounts of the Al, Si and Mn added; however, in a case where most of Al, Si and Mn are combined with O (oxygen) to thereby cause the occurrence, and it becomes impossible to bring about the strength-enhancing effect of these elements. Thus, in the present invention, O (oxygen) is limited to be not more than 0.003 % so that the occurrence of the oxide inclusions may be suppressed as much as possible. In other words, since Al, Si and Mn are added to obtain the strength-enhancing effect brought about by these oxide inclusion-forming elements, it becomes important to limit the amount of oxygen.

Therefore, the present invention is different from Pinnow, especially with respect to the means for enhancing the strength, such that the amounts of the elements of the present invention are different from those of Pinnow. Accordingly, Pinnow fails to teach or suggest the maraging steel of the present invention.

JP 9-263907:

JP-9-263907 discloses an alloy for a soft magnetic material used for a torque sensor which contains, as an indispensable element of the alloy, not less than 0.1 % Ti.

Thus, in the alloy of JP-9-263907, magnetic properties such as ferro-magnetism, soft-magnetism, magnetostriction and magnetostrictive effect and mechanical properties such as strength and resistance to repetitive torque load are required. In addition, JP-9-263907 discloses that Ti is an element that brings about precipitation hardening of the alloy without substantially deteriorating the high sensor output of the low carbon Fe-Ni alloy, and the amount of Ti is needed to be at least 0.1 % because when the Ti content is less than 0.1 %, the rate of the precipitation becomes slow and the degree of the obtained precipitation-hardening becomes small. That is, Ti is added in an amount not less than 0.1 % for the purpose of enhancing the strength and magnetic properties of the alloy. Further, in the specific examples disclosed in JP-9-263907, the lowest amount of Ti is 0.12 %, and in one example Ti of 1.48% is added.

Therefore, the amount of Ti in the specific examples in JP-9-263907 is out of the Ti range of the present invention, which is not more than 0.05%.

In addition, a feature of the present invention is that the amount of Ti is not more than 0.05 % and the amount of N to less than 0.005 %, to reduce the amount of TiN inclusion, which is detrimental to the enhancement of the fatigue strength. This is because the maraging steel of the present invention is intended to have such a high fatigue strength so that it can properly be used as high fatigue strength members, such as a power transmission belt, used, for example, in a continuously variable transmission of an automobile. The amount of Ti-based non metallic inclusions, which initiate the fatigue fracture is reduced as much as possible, and the size of the existing Ti-based non-metallic inclusions are made to be small. In other words, the amount of Ti must be suppressed or reduced.

If such a high amount of Ti as disclosed in JP-9-263907 is added, the fatigue strength of the steel will deteriorate at a very high cycle range. Although in JP-9-263907 the amount of Ti is raised, no caution is taken regarding the amounts of carbon and nitrogen which result in TiN and TiCN, which act to initiate the fatigue fracture at a very high cycle, so it is inevitable that the risk of the occurrence of fatigue fracture becomes very high. Thus, it is impossible to use the alloy of the JP-9-263907 as a material for a high fatigue strength member such as a power transmission belt, used, for example, in a continuously variable transmission of an automobile.

Therefore, Applicants respectfully submit that the present invention is not taught or suggested by JP 9-263907, especially since JP 9-263907 discloses an alloy having a Ti content outside the range of the present invention.

Cozar et al.:

Cozar relates to connection leads used for an electronic component, and, judging from the chemical composition and structure recited in claims 2, 3 and the claims depending thereon, an alloy capable of being called a "maraging steel" is disclosed. Since the metal structure of the maraging steel is a martensitic structure, an alloy having austenitic structure cannot be called "maraging steel".

However, in the alloy of Cozar as recited in claim 2, Ti is contained in an amount greater than in the present invention, which requires not more than 0.05% Ti. In contrast, the alloy of Cozar contains at least 0.1% of Ti. Accordingly, Cozar does not teach or suggest the alloy of the present invention.

In addition, Cozar discloses an alloy the range of the amount of Co is a very wide range as to be up to 30%, so that the alloy may satisfy the combination of any

electrical properties and any mechanical properties. Furthermore, claim 3 of Cozar recites the preferred range of the alloy composition recited in claim 2, which is characterized by a high amount of Co and a high amount of Ti that are typical in a conventional maraging steel.

Thus, the maraging steel of the present invention is different from the steel of Cozar.

Moreover, the maraging steel of the present invention has the four features explained above, and the non-metallic inclusion-forming elements such as C, N and O (oxygen) are controlled to be present in very low levels so that the occurrence of the non-metallic inclusions acting to deteriorate the fatigue strength at a very high cycle may be suppressed.

In contrast, Cozar relates to connection leads, which are basically unconcerned with fatigue strength needed in a fatigue range for high cycle, and reducing the amount of N, C and O is not taught at all by Cozar.

In view of the above, the present invention is not taught or suggested by Cozar.

SU 551404:

SU 551404 discloses an alloy containing 0.1 to 1.3 % Ti and a high amount of V (4.0 to 8.5 %). In contrast, in the present invention, the amount of Ti is less than 0.05% and vanadium is present as an impurity.

Therefore, the maraging steel of the present invention has a different composition from the alloy of SU 551404.

In view of the above, Applicants respectfully submit that Pinnow, JP 9-263907, Cozar and SU 551404 fail to teach or suggest the present invention. Accordingly,

Applicants respectfully request that the rejection be withdrawn.

II. **Response to rejection of claims 7 and 17 under 35 U.S.C. § 103(a)**

On pages 3-4 of the Office Action, the Examiner rejects claims 7 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Pinnow et al. (U.S. Patent 5,538,683), JP 9-263907, Cozar et al. (U.S. Patent 5,888,848) or SU 551404, and further in view of Whitaker.

Applicants respectfully respond as follows.

Applicants submit that claims 7 and 17 should be allowed by virtue of their dependence from claims 1 and 11, respectively, which are not taught or suggested by the prior art as discussed above.

In addition, Whitaker discloses an alloy containing 2 % Mo. In contrast, the maraging steel of the present invention contains 3.0 to 7.0 % Mo, and when the content of Mo is less than 3.0 %, the tensile strength of the maraging steel deteriorates to an unacceptable level.

Further, the Examiner takes the position that Whitaker discloses a grain size similar to that of the maraging steel of the invention. However, a person ordinarily skilled in the art would not be motivated to combine the above-cited references with Whitaker, which discloses an alloy containing such a low level of Mo as 2 %, when providing a high fatigue strength member, such as a power transmission belt, used, for example, in a continuously variable transmission of an automobile, in which the member should contain Co not less than 3%.

In view of the above, Applicants respectfully request that the rejection be withdrawn.

III. Response to rejection of claims 8-10 and 18-20 under 35 U.S.C. § 103(a)

On page 4 of the Office Action, the Examiner rejects claims 8-10 and 18-20 under 35 U.S.C. § 103(a) as being unpatentable over Pinnow et al. (U.S. Patent 5,538,683), JP 9-263907, Cozar et al. (U.S. Patent 5,888,848) or SU 551404 further in view of JP 62-080225 or JP 63-026345.

Applicants respectfully respond as follows.

Applicants submit that claims 8-10 and 18-20 should be allowed by virtue of their dependence from claims 1 and 11, respectively, which are not taught or suggested by the cited prior art as discussed above.

In addition, each of the cited prior art references only discloses a nitriding treatment applied to a conventional maraging steel. In the strip recited in each of claims 8 to 10 and 18 to 20 of the present application, the maraging steel of the present invention is used. Since none of the cited prior art references teaches or suggests the maraging steel of the present invention, the strips of the present invention are not taught or suggested by the combination of JP-62-080225 or JP-63-026345 with the cited prior art references.

In view of the above, Applicants respectfully request that the rejection be withdrawn.

IV. Conclusion

Reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number

listed below.

Applicant hereby petitions for any extension of time which may be required to maintain the pendency of this case, and any required fee, except for the Issue Fee, for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims are amended as follows:

1. (amended) A maraging steel having high fatigue strength, consisting essentially, by mass, of not more than 0.008% C, from 0 inclusive but not more than 2.0% Si, from 0 inclusive but not more than 3.0% Mn, not more than 0.010% P, not more than 0.005% S, 12 to 22% Ni, 3.0 to 7.0% Mo, less than 7.0% Co, not more than [0.1] 0.05% Ti, not less than 0.06 % and not more than 2.0% Al, less than 0.005% N (nitrogen), not more than 0.003% O (oxygen), and the balance substantially Fe, a total amount of (3Si + 1.8Mn + Co/3 + Mo + 2.6Ti + 4Al) being in a range of 8.0 to 13.0%.

11. (amended) A maraging steel having high fatigue strength, consisting essentially, by mass, of not more than 0.008% C, from 0 inclusive but not more than 1.0% Si, from 0 inclusive but not more than 2.0% Mn, not more than 0.010% P, not more than 0.005% S, 12 to 22% Ni, 3.0 to 7.0% Mo, less than 7.0% Co, not more than 0.05% Ti, not less than 0.06% and not more than 2.0% Al, less than 0.005% N (nitrogen), not more than 0.003% O, and the balance substantially Fe, a total amount of (3Si + 1.8Mn + Co/3 + Mo + 2.6Ti + 4Al) being in a range of 8.0 to 13.0%.

Claims 21-23 are added as new claims.